# Evolution of the Continental Slope: Mechanics of Debris Flows and Landscape Evolution Modeling

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## LONG-TERM GOALS

The long-term goal of the project is to incorporate the mechanics of submarine debris flows and associated turbidity currents on the continental slope into a predictive model of the evolution of continental slope morphology and stratigraphy.

## OBJECTIVES

The objectives of the project are as follows. 1. Characterize the dynamics of flow and deposition of submarine debris flows. 2. Characterize their devolution into turbidity currents, and the dynamics of flow and deposition of those turbidity currents. 3. Incorporate the understanding of event dynamics into a model of continental slope evolution.

## APPROACH

The research is being pursued through experimental, theoretical and numerical means. Experiments are being conducted in three facilities. The "Fish Tank," a large facility developed for the study of submarine debris flows and turbidity currents, is being used to study 2-D flows. The "Imran Tank" is a smaller facility used to study 3-D debris flows. The "Garcia Tank," a facility specifically designed for continuous turbidity currents, is being used to study the filling of minibasins on the continental slope by turbidity currents. In addition, the "Garcia Tank" is also being used to study the progradation of a simple margin consisting of a sandy topset and foreset and a muddy bottomset emplaced by turbidity currents. Theoretical and numerical research is proceeding in parallel on all topics. The research is being tied into field observations through cooperation with other researchers in STRATAFORM and field research conducted by the broader research community.

## WORK COMPLETED

The following work was performed in Fiscal Year 2000 (October 1, 1999 to September 30, 2000).

- Data previously obtained was analyzed to obtain quantitave results in regard to the ability of a 3-D debris flow to rework a previous debris flow deposit as it overrides it.

- Experiments were performed on 3-D subaqueous debris flows in order to evaluate the performance of a numerical model developed by L. Pratson in cooperation with the Minnesota group.
- Experiments were performed on the filling of continental slope minibasins by turbidity currents. The experiments were used to develop a first theory of minibasin filling.
- Experiments were performed on simple prograding margins consisting of a fluvial topset, an avalanching foreset and a bottomset emplaced by turbidity currents. The experiments are being used to test a moving-boundary numerical model of the phenomenon developed during the period in question.
- A theory was developed to describe the hydroplaning of outrunner blocks (glide blocks) and auto-acephalated heads of debris flows. The theory was applied to both experimental and field results.
- A theory was developed to explain how turbidity currents overriding a coarse-grained Gilbert delta can substantially reduce its slope. Two experiments were performed to verify this.

**RESULTS**

Major results of the research performed in the aforementioned fiscal year can be summarized as follows.

- A subaerial debris flow can immediately rework the preceding flow. In the subaqueous environment, however, several succeeding flows can merely drape the deposit, until it becomes sufficiently thick so that the next flow produces massive reworking.
- Minibasins on continental margins fill by passive settling from a muddy reservoir. In the case of sediment of uniform size, the deposit thickness is uniform in space. In the case of sediment mixtures, the deposit is thickest at the deepest point of the basin, which is also richest in coarser material (sand).
- A moving boundary model can accurately describe the progradation of a simple margin with a fluvial topset, an avalanching foreset and a bottomset emplaced by a depositional turbidity current.
- Overriding turbidity currents can substantially decrease the angle of the foreset of a prograding margin.
- Outrunner glide blocks approach an equilibrium state of glide at which the relevant densimetric Froude number is order-one. Glide blocks can move long distances on very low slopes.

**IMPACT/APPLICATIONS**

Several impacts and applications of the work can be described as follows.

- Reworking of debris flow deposits appears to be episodic, with major reworking occurring only after several preceding events that simply drape.
- The best place to look for sand in minibasins on continental slopes may be near the deepest point of the basin.
- Overriding turbidity currents can reduce the slope of sandy foreset deposits to below 1°.

## TRANSITIONS

Some of the above results are being imbedded into a broad-brush model of continental margins, the development of which is being overseen by M. Steckler.

## RELATED PROJECTS

The research on submarine debris flows and minibasin filling is also being supported by the Jurassic Tank Oil Consortium. The research on prograding deltas is also being supported by the Minnesota Sea Grant program.

## REFERENCES

No references are quoted above.

## PUBLICATIONS

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## PATENTS

No patents have been obtained or applied for.